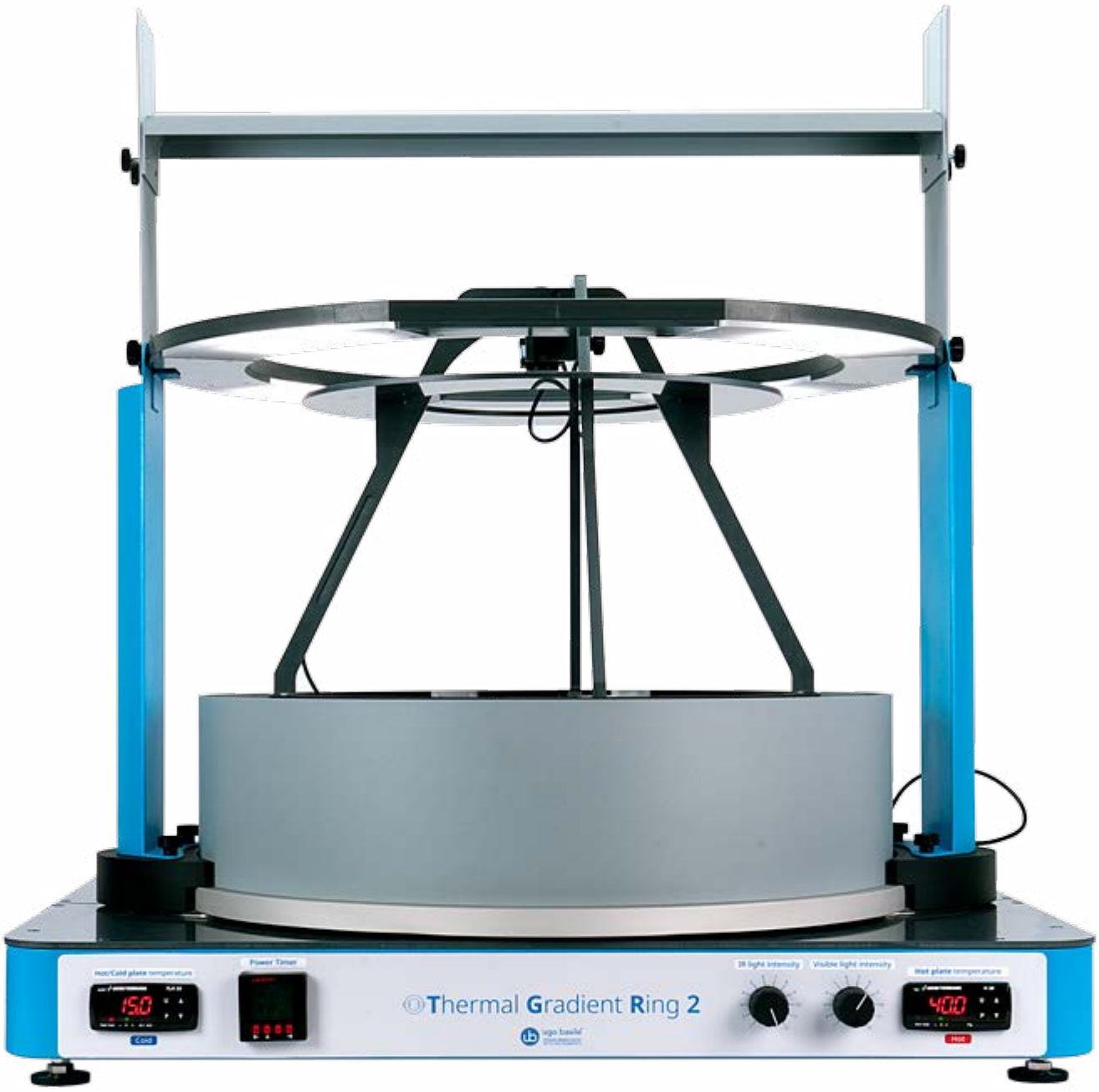
Thermal Gradient Ring

Literature review

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1. TGR scientific evidence at a glance

The Thermal Gradient Ring (TGR) (SKU 35530) has evolved from a novel circular thermal-preference paradigm into a research platform used across pain, sensory neuroscience, metabolism and disease models. The literature now spans a decade, from the foundational 2016 method paper to 2026 studies applying the TGR to experimenter-free pharmacological pain assessment and new translational disease questions.

Description		
Method & Validation	Circular, duplicated gradient; high thermal resolution; reduced spatial confounds; free-moving assessment.	Touska 2016 Winter 2017 Ujisawa 2024
Pain & Pharmacology	Spontaneous thermal choice, longitudinal behavior and motor activity without evoked-response scoring.	Bertamino 2020 Valek 2022 Garcia 2026 Vanegas 2026
Neuropthy & Disease Phenotyping	Detection of altered thermal preference/ avoidance, including early or subtle sensory dysfunction.	Sasajima 2022 Hakim 2025 Gaffney 2026
TRP Channels & Thermosensation	Detailed phenotyping of TRPM8, TRPA1, TRPV1, TRPV3 and other thermosensitive pathways.	Ujisawa 2022 Lei 2023 Ujisawa 2024
Metabolism & Thermoregulation	Behavioral readout of thermogenic state and adaptive thermoregulation.	Sankina 2024 De Melo 2025
Neurodegeneration	Thermal sensory phenotyping in Parkinson-related models.	Valek 2021 Franck 2026

Key evolution in 2025–2026: the evidence base expands beyond classical thermal sensitivity into non-invasive thermogenesis and experimenter-free pharmacological pain assessment.

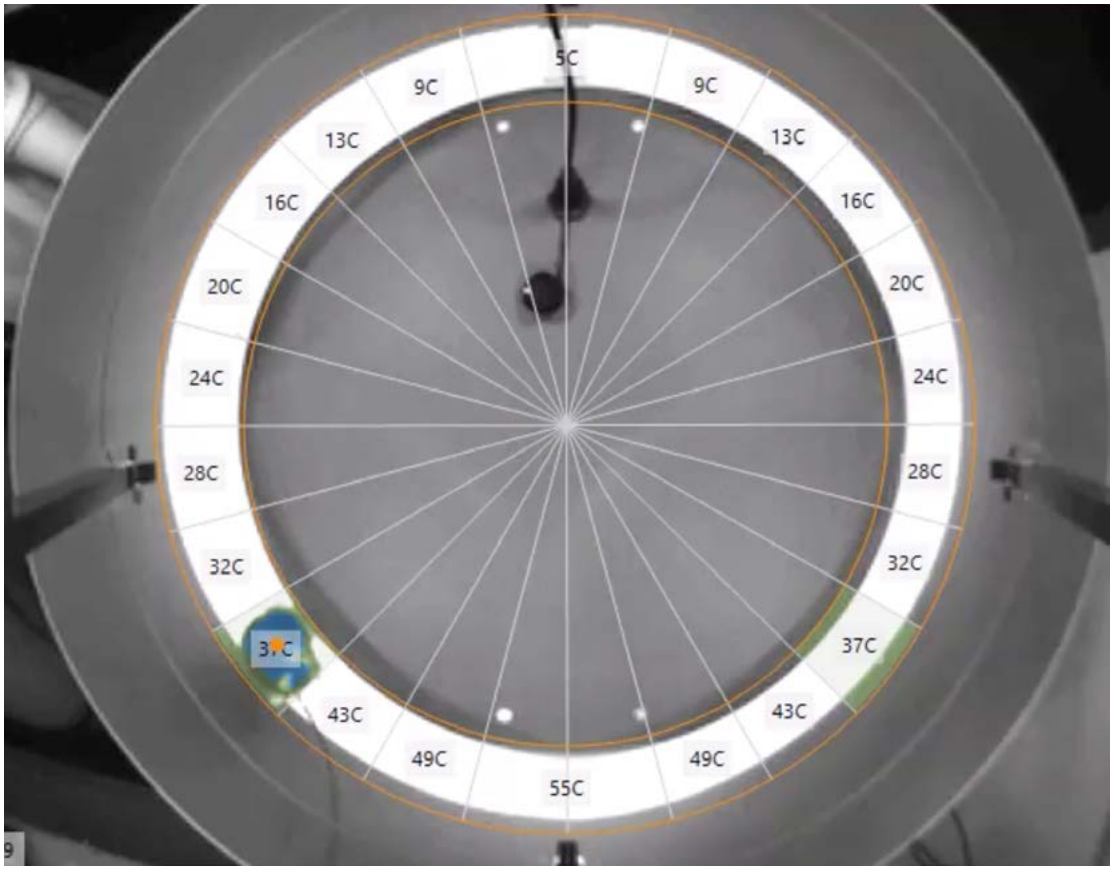
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https://ugobasile.com/products/categories/pain-and-inflammation/new-thermal-gradient-ring-tgr-zimmermann-s-method-2-0

2. Why the Thermal Gradient Ring

Temperature-based behavioral assays are widely used to investigate nociception, thermal sensitivity, ion-channel function and pharmacological effects. Conventional assays can be highly effective for specific endpoints, particularly acute evoked responses, but they may not fully capture spontaneous thermal preference or avoidance across a broad temperature range.

The TGR addresses a different experimental question. Mice move freely around a circular runway spanning a thermal gradient, while position and movement are tracked over time. The ring geometry removes corners and duplicates the gradient across the two halves of the apparatus, reducing spatial confounds and providing repeated thermal zones. The approach therefore combines thermal choice with behavioral information such as zone occupancy, travel distance, moving speed, acceleration and crossings.

The scientific value of this paradigm is not simply that the animal "chooses a temperature." Across the literature, TGR data have been used to distinguish preference from avoidance, identify subtle sensory phenotypes, characterize time-dependent behavior, assess pharmacological effects and, more recently, infer thermoregulatory and metabolic state.



What the literature consistently report

- Free-moving, spontaneous thermal preference/avoidance rather than a forced endpoint.
- Circular design that avoids corner preference and reduces spatial confounds.
- High thermal resolution across multiple zones, with duplicate values on the two semicircles.
- Automated tracking that reduces direct experimenter involvement during data acquisition.
- Multi-parameter analysis: thermal occupancy can be interpreted together with locomotor and time-dependent behavior.

3. From method development to a validated research tool

3.1. Comprehensive thermal preference phenotyping in mice using a novel automated circular gradient assay

F. Touska et al., 2016, Temperature

The foundational method paper introduced the automated circular gradient paradigm to improve the phenotyping of thermal sensitivity in mice. The study showed that subtle changes in normal cold sensitivity, cold hypersensitivity and cold hyperalgesia may be difficult to resolve with simpler paradigms. By allowing longer, operator-independent observation across a gradient, the assay revealed previously unrecognized features of TRPM8-, TRPA1- and combined TRPM8/TRPA1-deficient mice.

- Established the rationale for a circular rather than linear or two-choice design.
- Demonstrated the value of longer observation windows and reduced operator intervention.
- Positioned the gradient assay as complementary to acute nociception tests, because it integrates peripheral input with central temperature perception and behavioral thermoregulation.

Read the article: https://doi.org/10.1080/23328940.2015.1135689

3.2. Cold Temperature Encoding by Cutaneous TRPA1 and TRPM8-Carrying Fibers in the Mouse

Z. Winter et al., 2017, Frontiers in Molecular Neuroscience

Using the thermal ring track adjusted from approximately 30 to 5 °C, the authors investigated the relative contribution of TRPM8 and TRPA1 to cold sensing. Double-knockout mice showed a larger reduction in cold avoidance than TRPM8-deficient mice, supporting a cooperative role in cold-temperature encoding.

- Demonstrated how the ring can resolve genotype-dependent differences in cold avoidance.
- Supported the use of the paradigm for mechanistic studies of thermosensitive ion channels.

Read the article: https://doi.org/10.3389/fnmol.2017.00209

3.3. Thermal gradient ring for analysis of temperature-dependent behaviors involving TRP channels in mice

T. Ujisawa et al., 2024, The Journal of Physiological Sciences

This review/method article consolidates the scientific rationale for the TGR and highlights the importance of analyzing more than spent time alone. Travel distance, moving speed and acceleration can help distinguish comfort, avoidance and exploratory behavior across temperature zones. The paper also summarizes applications in TRP-channel biology, neuropathic pain, Parkinson-related phenotypes, diabetic peripheral neuropathy and somatic thermosensation.

- Provides a mature methodological framework for interpreting TGR behavior.
- Shows how multiple behavioral parameters can clarify thermal preference and avoidance.
- Documents the broadening of TGR applications beyond its original TRP-channel context.

Read the article: https://doi.org/10.1186/s12576-024-00903-w

4. Neuropathic pain & sensory dysfunction

Neuropathy is one of the strongest application areas in the TGR literature. Across diabetic, genetic, neurodegenerative and cancer-associated models, the ring has been used to detect altered thermal choice and to determine whether sensory dysfunction is present even when conventional measures or gross behavior show limited changes.

4.1. Macrophages protect against sensory axon loss in peripheral neuropathy

S. Hakim et al., 2025, Nature

In a high-fat, high-fructose diet model, the TGR was used to assess thermal preference before overt axonal degeneration. Mice with metabolic dysfunction showed altered distribution across the gradient, with greater occupancy of warmer regions and increased avoidance of cooler regions. The study linked early functional sensory changes to SARM1-dependent axonal dysfunction and macrophage-mediated neuroprotection.

- Supports TGR use for early sensory phenotyping before structural nerve loss becomes evident.
- Demonstrates value in metabolic/peripheral neuropathy models and complements forced-response assays such as Hargreaves and von Frey.

Read the article: https://doi.org/10.1038/s41586-024-08535-1

4.2. Thermal gradient ring reveals thermosensory changes in diabetic peripheral neuropathy in mice

S. Sasajima et al., 2022, Scientific Reports

The study used the TGR to investigate thermal preference and avoidance in diabetic peripheral neuropathy and to compare disease-related behavior with TRPV1-related phenotypes. The circular gradient clearly discriminated temperature-dependent behavior and supported the interpretation of both preference and avoidance components.

- Provides disease-specific validation in diabetic peripheral neuropathy.
- Shows the value of mapping behavior across a gradient rather than relying on a single temperature endpoint.

Read the article: https://doi.org/10.1038/s41598-022-14186-x

4.3. Prodromal sensory neuropathy in Pink1-/-SNCAA53T double mutant Parkinson mice

L. Valek et al., 2021, Neuropathology and Applied Neurobiology

Pink1-/-SNCAA53T mice showed normal mechanical withdrawal but a strong loss of heat sensitivity in Hargreaves and hot-plate testing, together with a preference for cooler temperatures in the TGR. The combined results suggested altered thermal sensation in a prodromal Parkinson model.

- Extends TGR use to neurodegenerative disease models.
- Illustrates how spontaneous thermal choice can complement reflex-based thermal testing.

Read the article: https://doi.org/10.1111/nan.12734

Inflammatory neuropathy in mouse and primate models of colorectal cancer

C. M. Gaffney et al., 2026, Nature Communications

The final peer-reviewed study reports peripheral neuropathy in colorectal cancer models associated with inflammatory and structural changes. In the mouse model, the TGR did not show an overt shift in temperature preference or aversion during the assessed time points, while other analyses revealed subtle locomotor and neuropathic changes.

- A useful negative TGR result: absence of a thermal-preference shift helps define the phenotype rather than weakening the assay.
- Replaces the 2024 bioRxiv citation used in the previous review with the final 2026 publication.

Read the article: https://doi.org/10.1038/s41467-026-76683-1

5. Pain & pharmacological research

A major 2026 development is the explicit use of the TGR as an experimenter-free pharmacological pain-assessment platform. This strengthens a positioning already suggested by earlier studies: the TGR can add a spontaneous, motivational component to thermal pain research while simultaneously tracking locomotor behavior.

5.1. Experimenter-free pain assessment in mice using a thermal gradient ring and functional linear models

A. Garcia et al., 2026, Pain Reports

This study directly evaluated the TGR for pharmacotherapy assessment. Male and female mice were tested across 17 treatment conditions including pronociceptive and antinociceptive manipulations. The authors paired TGR behavioral data with functional linear models, enabling time-resolved hypothesis testing of temperature preference and motor activity throughout the session.

- Directly addresses experimenter bias, motor confounds and limitations of conventional evoked pain tests.
- Uses high-resolution, time-dependent analysis rather than reducing the session to a single summary value.
- Provides particularly strong evidence for positioning the TGR in analgesic and pharmacological screening workflows.

Read the article: https://doi.org/10.1097/PR9.0000000000001469

5.2. Exploration of TRPM8 Binding Sites by β-Carboline-Based Antagonists and Their In Vitro Characterization and In Vivo Analgesic Activities

A. Bertamino et al., 2020, Journal of Medicinal Chemistry

In a chronic constriction injury model, neuropathic mice showed a marked preference for colder areas of the ring, most prominently during the first 45 minutes and extending through the 60-minute session. The work connected TRPM8 pharmacology with in vivo thermal behavior.

- Demonstrates the use of TGR in drug-discovery research targeting TRPM8.
- Shows how the time course of thermal preference can be informative in neuropathic pain.

Read the article: https://doi.org/10.1021/acs.jmedchem.0c00816

5.3. Cold avoidance and heat pain hypersensitivity in neuronal nucleoredoxin knockout mice

L. Valek et al., 2022, Free Radical Biology and Medicine

Neuronal nucleoredoxin knockout mice showed cold avoidance in the TGR, while neuropathic and inflammatory nociceptive models revealed subtle heat-nociception phenotypes. The study illustrates the sensitivity of combined behavioral approaches to phenotypes that may be modest in magnitude.

- Supports TGR use in mechanistic pain research.
- Highlights the value of subtle phenotype detection.

Read the article: https://doi.org/10.1016/j.freeradbiomed.2022.09.010

5.4. Anti-inflammatory and analgesic potential of minor cannabinoids in vivo

S. O. Vanegas et al., 2026, Journal of Cannabis Research

The TGR was used in an LPS-induced inflammatory pain model to quantify thermal preference and distance traveled after treatment with minor cannabinoids. CBN-treated mice showed thermal preferences comparable with controls, while locomotor changes were also detected, illustrating the importance of interpreting thermal preference together with movement.

- New pharmacological application in inflammatory pain.
- Shows why simultaneous locomotor readouts are valuable when interpreting drug effects on thermal choice.

Read the article: https://doi.org/10.1186/s42238-025-00384-7

5.5. Cold nociception as a measure of hyperalgesia during spontaneous heroin withdrawal in mice

L. E. Hastings et al., 2024, Pharmacology Biochemistry and Behavior

Mice undergoing spontaneous heroin withdrawal preferred higher temperatures in the thermal gradient. The study compared cold-related behavioral approaches and supports the use of thermal choice as an additional readout of withdrawal-associated hyperalgesia.

- Extends the TGR evidence base to opioid withdrawal.
- Demonstrates sensitivity to changes in spontaneous temperature choice.

Read the article: https://doi.org/10.1016/j.pbb.2023.173694

6. TRP channels & thermosensation

TRP-channel research remains the mechanistic foundation of the TGR evidence base. The circular gradient is particularly suited to questions in which the phenotype is not simply "response/no response," but a change in preferred range, avoidance threshold, movement pattern or the time needed to discriminate comfortable from uncomfortable temperatures.

6.1. Thermal gradient ring reveals different temperature-dependent behaviors in mice lacking thermosensitive TRP channels

T. Ujisawa et al., 2022, The Journal of Physiological Sciences

Six TRP-deficient genotypes (TRPA1, TRPM2, TRPM8, TRPV1, TRPV3 and TRPV4) were studied using the duplicated thermal gradient. The analysis went beyond spent time to include travel distance, moving speed and acceleration. In particular, acceleration at temperatures below approximately 14.4 °C differentiated TRPM8-deficient mice from other genotypes.

- Demonstrates the value of multi-parameter analysis for thermal phenotyping.
- Addresses limitations of linear apparatuses and low-resolution two-plate approaches.

Read the article: https://doi.org/10.1186/s12576-022-00835-3

6.2. Involvement of skin TRPV3 in temperature detection regulated by TMEM79 in mice

J. Lei et al., 2023, Nature Communications

The TGR was used to examine spent time and moving speed across 12 temperature zones over one hour. Wild-type and TRPV3-deficient mice differed in the breadth and timing of their preferred temperature ranges. Time-course analysis and movement speed helped distinguish when animals identified comfortable zones.

- Shows that temporal dynamics can be as informative as total zone occupancy.
- Supports a role for skin TRPV3 in temperature detection.

Read the article: https://doi.org/10.1038/s41467-023-39712-x

6.3. The Human SCN9A^{R185H} Point Mutation Induces Pain Hypersensitivity and Spontaneous Pain in Mice

Y. Xue et al., 2022, Frontiers in Molecular Neuroscience

Thermal preference was assessed across non-noxious temperatures from 15 to 40 °C in a mouse model carrying a human SCN9A gain-of-function mutation associated with small-fiber neuropathy. The TGR contributed a spontaneous thermal-preference endpoint alongside other pain measures.

- Illustrates use in translational pain genetics.
- Also demonstrates the value of a well-characterized negative or modest thermal phenotype.

Read the article: https://doi.org/10.3389/fnmol.2022.913990

7. Metabolism, thermoregulation & energy homeostasis

This is the application area that has expanded most clearly since the previous edition. The TGR is now being used not only to study sensory temperature detection, but also as a non-invasive behavioral window into thermoregulation and thermogenic capacity.

7.1. Behavior-driven monitoring of thermogenesis in mice using a thermal gradient ring

P. De Melo et al., 2025, American Journal of Physiology-Endocrinology and Metabolism

The study validated the TGR as a non-invasive method for monitoring thermoregulatory behavior and thermogenic state. Preferred temperature, zone occupancy, locomotion patterns and distance were evaluated in models with increased or reduced thermogenesis, including β-adrenergic stimulation, high-fat diet, brown-adipose-tissue lipectomy, UCP1 deficiency and cold exposure.

- Moves the TGR beyond pain and ion-channel research into metabolic physiology.
- Demonstrates continuous, behavior-driven assessment without rectal probes, surgery or repeated handling.
- Shows that animals dynamically adjust locomotion and zone occupancy in ways that reflect metabolic state.

Read the article: https://doi.org/10.1152/ajpendo.00133.2025

7.2. Topical menthol, a pharmacological cold mimic, induces cold sensitivity, adaptive thermogenesis and brown adipose tissue activation in mice

P. Sankina et al., 2024, Diabetes, Obesity and Metabolism

After topical menthol, male mice developed a warm-seeking, cold-avoiding phenotype in the TGR, together with increased locomotor activity and adaptive thermogenesis. During the first 30 minutes, treated animals spent more time in warmer zones and avoided temperatures around 20–24 °C.

- Links TRPM8-related cold signaling to adaptive thermogenesis.
- Demonstrates the value of combining thermal preference with locomotor behavior.

Read the article: https://doi.org/10.1111/dom.15781

8. Neurodegeneration & emerging applications

8.1. Modest improvement of metabolic and behavioral deficits with long-term ambroxol treatment in a Pink1-/-SNCAA53T double mutant mouse model of Parkinson's disease

L. Franck et al., 2026, Acta Pharmacologica Sinica

This 2026 study extends the use of the TGR in the Pink1-/-SNCAA53T Parkinson model. Thermal preference and exploration of the circular platform were included within a broader behavioral and metabolic assessment of long-term ambroxol treatment.

- Strengthens the evidence for TGR use in Parkinson-related sensory phenotyping.
- Shows integration of TGR into multi-domain preclinical treatment studies.

Read the article: https://doi.org/10.1038/s41401-025-01690-9

8.2. Repetitive and compulsive behavior after Early-Life-Pain associated with reduced long-chain sphingolipid species

A. Vogel et al., 2023, Cell & Bioscience

TGR behavior was comparable between experimental and control mice, indicating preserved warm and cold sensation. This negative result was informative because it helped exclude sensory neuropathy or loss of thermal sensation as an explanation for other behavioral findings.

- Shows the value of TGR as a control/phenotyping tool, not only for positive effects.
- Normal TGR behavior can help rule out altered thermosensation as a confound.

Read the article: https://doi.org/10.1186/s13578-023-01106-3

8.3. Optogenetic Early Life Pain leads to cortical hyperexcitability, nociceptive hypersensitivity and repetitive behavior

I. Tegeder et al., 2022, Research Square [preprint]

The TGR was used to assess temperature preference and exploration after early-life optogenetic pain. Experimental mice were comparable with controls in the ring, supporting preserved warm and cold sensation despite other nociceptive and behavioral changes.

- Useful example of TGR as a sensory-control assay.

Read the article: https://doi.org/10.21203/rs.3.rs-2051833/v1

9. What can the TGR reveal?

The literature does not support treating the TGR as a universal replacement for hot plate, cold plate, Hargreaves or two-temperature choice tests. These methods answer different experimental questions. The accumulated evidence instead supports the TGR as a complementary paradigm when the research question concerns spontaneous thermal choice, subtle phenotyping or the evolution of behavior across a range of temperatures.

Experimental Question	Coventional Endpoint	What TGR adds	Evidence
Does the animal respond to a defined thermal stimulus?	Latency / paw lift / withdrawal / scored behavior	Not the primary purpose of TGR; use conventional acute nociception tests when this is the main endpoint.	Touska 2016; Garcia 2026
Which temperatures are preferred or avoided?	Often one or two fixed temperatures	A full gradient with multiple thermal zones and duplicated values.	Touska 2016; Ujisawa 2022
Is the phenotype subtle or time-dependent?	Single summary endpoint	Zone-by-zone and time-resolved preference plus locomotor measures.	Lei 2023; Garcia 2026
Could spatial preference confound thermal choice?	Linear ends / two chambers	Circular track without corners; reduced spatial confounds.	Touska 2016; Ujisawa 2024
Could treatment alter locomotion as well as thermal preference?	Thermal endpoint may be interpreted separately	Movement and thermal occupancy can be analyzed together.	Vanegas 2026; De Melo 2025
Is altered thermoregulation part of the phenotype?	Core-temperature measurements often require handling/ probes	Behavioral thermoregulation can be monitored continuously and non-invasively.	De Melo 2025; Sankina 2024

Scientific synthesis: TGR does not simply measure where a mouse stays. Across the literature, it is used to reveal how thermal preference and avoidance develop over time, how movement changes across the gradient, and how these behaviors vary with genotype, disease state or pharmacological treatment.

10. Practical interpretation of TGR data

The 2022–2026 literature increasingly emphasizes that no single TGR variable should automatically be interpreted in isolation. “Spent time” is intuitive, but movement-related parameters and the time course of the session can change the biological interpretation.

Zone occupancy / spent time: Identifies the thermal regions in which animals remain, but should be interpreted together with exploration and locomotion when drug treatment or disease may affect activity.

Preferred temperature: A useful summary of thermal choice, especially when comparing treatment groups or genotypes; the distribution around that value may also be biologically informative.

Moving speed and acceleration: Can help distinguish comfort from rapid passage through an aversive zone and can reveal temperature-dependent behavioral responses not apparent from occupancy alone.

Travel distance and crossings: Provide context for overall activity and exploration, helping identify motor effects that could otherwise complicate interpretation of thermal preference.

Time-resolved analysis: Can reveal when a preference emerges, whether animals habituate, and whether treatment effects are transient or sustained. Garcia 2026 further develops this concept using functional linear models.

11. Conclusions

The Thermal Gradient Ring literature has developed along two parallel directions. First, the original methodological strengths of the circular gradient have been repeatedly reinforced: high thermal resolution, free movement, reduced spatial confounds, automated acquisition and the possibility of integrating several behavioral parameters. Second, the range of biological questions has expanded substantially.

The strongest established fields remain TRP-channel biology, thermal sensitivity and neuropathic pain. However, recent publications show clear growth in pharmacological pain assessment, peripheral neuropathy, metabolism, thermogenesis and neurodegenerative disease. The 2025 De Melo paper is particularly important because it validates the TGR as a non-invasive tool for behavior-driven monitoring of thermogenesis, while Garcia 2026 provides direct evidence for experimenter-free pharmacological pain assessment with time-resolved statistical analysis.

Taken together, the evidence supports the TGR as a research platform for studies in which spontaneous thermal preference and avoidance are themselves meaningful phenotypes. Its value is greatest when researchers need to resolve subtle or time-dependent effects, reduce direct experimenter involvement, distinguish thermal choice from locomotor behavior, or characterize responses across a gradient rather than at one or two predefined temperatures.

12. Selected Bibliography (Updated 2026)

- Garcia A et al. (2026). Experimenter-free pain assessment in mice using a thermal gradient ring and functional linear models. Pain Reports.
- Gaffney CM et al. (2026). Inflammatory neuropathy in mouse and primate models of colorectal cancer. Nature Communications.
- Vanegas SO et al. (2026). Anti-inflammatory and analgesic potential of minor cannabinoids in vivo. Journal of Cannabis Research.
- Franck L et al. (2026). Modest improvement of metabolic and behavioral deficits with long-term ambroxol treatment in a Pink1-/-SNCAA53T double mutant mouse model of Parkinson's disease. Acta Pharmacologica Sinica.
- De Melo P et al. (2025). Behavior-driven monitoring of thermogenesis in mice using a thermal gradient ring. American Journal of Physiology-Endocrinology and Metabolism.
- Hakim S et al. (2025). Macrophages protect against sensory axon loss in peripheral neuropathy. Nature.
- Ujisawa T et al. (2024). Thermal gradient ring for analysis of temperature-dependent behaviors involving TRP channels in mice. The Journal of Physiological Sciences.
- Sankina P et al. (2024). Topical menthol, a pharmacological cold mimic, induces cold sensitivity, adaptive thermogenesis and brown adipose tissue activation in mice. Diabetes, Obesity and Metabolism.
- Hastings LE et al. (2024). Cold nociception as a measure of hyperalgesia during spontaneous heroin withdrawal in mice. Pharmacology Biochemistry and Behavior.
- Lei J et al. (2023). Involvement of skin TRPV3 in temperature detection regulated by TMEM79 in mice. Nature Communications.
- Vogel A et al. (2023). Repetitive and compulsive behavior after Early-Life-Pain associated with reduced long-chain sphingolipid species. Cell & Bioscience.
- Valek L et al. (2022). Cold avoidance and heat pain hypersensitivity in neuronal nucleoredoxin knockout mice. Free Radical Biology and Medicine.
- Sasajima S et al. (2022). Thermal gradient ring reveals thermosensory changes in diabetic peripheral neuropathy in mice. Scientific Reports.
- Ujisawa T et al. (2022). Thermal gradient ring reveals different temperature-dependent behaviors in mice lacking thermosensitive TRP channels. The Journal of Physiological Sciences.
- Xue Y et al. (2022). The Human SCN9AR185H Point Mutation Induces Pain Hypersensitivity and Spontaneous Pain in Mice. Frontiers in Molecular Neuroscience.
- Valek L et al. (2021). Prodromal sensory neuropathy in Pink1-/-SNCAA53T double mutant Parkinson mice. Neuropathology and Applied Neurobiology.
- Bertamino A et al. (2020). Exploration of TRPM8 Binding Sites by β-Carboline-Based Antagonists and Their In Vitro Characterization and In Vivo Analgesic Activities. Journal of Medicinal Chemistry.
- Winter Z et al. (2017). Cold Temperature Encoding by Cutaneous TRPA1 and TRPM8-Carrying Fibers in the Mouse. Frontiers in Molecular Neuroscience.

- Touska F et al. (2016). Comprehensive thermal preference phenotyping in mice using a novel automated circular gradient assay. Temperature.

Editorial note: Peer-reviewed publications are prioritized in this review. Preprints are explicitly labelled. The complete master bibliography should be maintained separately so that future website and literature-review updates can be synchronized.

13. Related Products

Estimates suggest that 20% of adults suffer from pain globally. Chronic pain is the most common cause of long-term disabilities.

Since 1963, Ugo Basile's devices have increasingly acquired a leading role in the field of pain and inflammation preclinical research, becoming precious tools for researchers to achieve their experimental objectives.



37240 - Plethysmometer - Paw Volume & Oedema



37550 - Dynamic Plantar Aesthesiometer - For Automated Mechanical Stimulation and Allodynia



38450 - Electronic Von Frey - e-VF Handheld



37450-275 - Von Frey Filaments manual touch sensitivity kit



37570 - Plantar Test for thermal stimulation - (Hargreaves Apparatus)



37560 - Tail Flick Unit - Thermal stimulation, D'Amour & Smith method



37300 - I.R. Heat-Flux Radiometer for Tail Flick and Plantar Test



37215 - Analgesy-Meter Randall-Selitto paw-pressure test



38500 - PAM Pressure Application Measurement (for joint pain)



31300 - Orofacial Stimulation Test (Fehrenbacher, Henry, Hargreaves method)



35300 - Hot/Cold Plate NG for screening of thermal hyperalgesia/allodynia



35350 - Thermal Place Preference (TPP Test) for Mice & Rats



47885 - Librae Incapacitance Tester (Weight Bearing)



36103 - Climbing Test - Measures Vertical Activity in Rodents



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